

MERRIMACK RIVER BASIN

SALEM, NEW HAMPSHIRE

**EAST DIKE
ARLINGTON MILL RESERVOIR
NH 00027**

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**



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New England District
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**DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154**

AUGUST 1978

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

SEP 28 1978

Honorable Meldrim Thomson, Jr.
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Thomson:

I am forwarding to you a copy of the East Dike Arlington Mill Reservoir Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

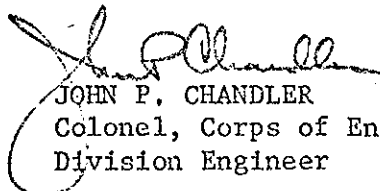
A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Spicket River Corp., 550 Broadway, Lawrence, Massachusetts 01841.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely yours,

Incl
As stated


JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

EAST DIKE
ARLINGTON MILL RESERVOIR

NH 00027

MERRIMACK RIVER BASIN
SALEM, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam East Dike, Arlington Mill Reservoir
State Located New Hampshire
County Located Rockingham
City or Town Salem
Stream Spicket River
Date of Inspection 6/7/78 and 6/28/78

Brief Assessment

The East Dike of Arlington Mill Reservoir is an earth fill saddle dike with concrete core wall extending to bedrock. Total length is 530 feet, and height from the crest to the lowest point in the downstream swale is 31 feet. The dike was built under the same contract as Wheeler Dam on Arlington Mill Reservoir and was completed in 1922. The dike has no spillway or discharge conduits, as these functions are performed at Wheeler Dam.

The East Dike is in overall good to fair condition. There is no evidence that the dike is unstable and no serious problems were detected. However, the downstream face is covered with trees and shrubs, some of the trees being quite large. This could lead to future problems, in that tree roots can become seepage paths over time. There are also some areas of marsh like grass on the downstream face, possibly indicating the onset of seepage.

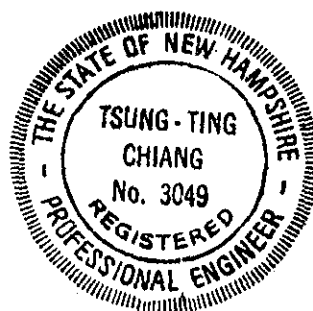
The reservoir test flood (equal to the probable maximum flood) would overtop the East Dike by about one foot. Overtopping potential is judged as moderate. Whether the structure would withstand this degree of overtopping is not certain. The hazard classification of the East Dike is significant-to-high, owing to its height and the volume of impounded water.

It is recommended that the owner cut all trees on the dike, and to retain a competent engineer to supervise removal and backfill of the tree roots. Professional advice should also be sought to investigate the apparent seepage.

WHITMAN & HOWARD, INC.

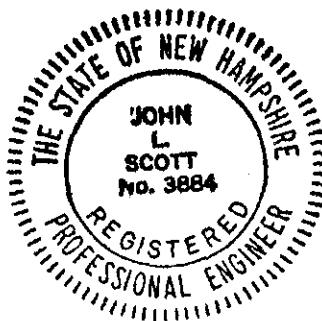
T. T. Chiang

T. T. Chiang, Ph.D., P.E.

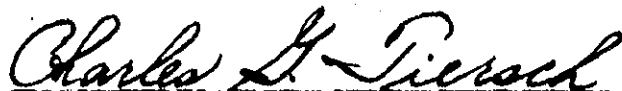


John L. Scott

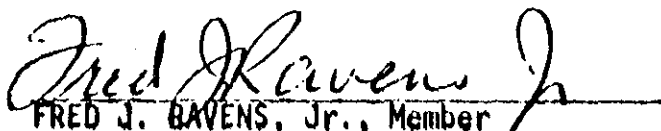
John L. Scott, P.E.



This Phase I Inspection Report on East Dike, Arlington Mill Reservoir has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.



CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division



FRED J. DAVENS, Jr., Member
Chief, Design Branch
Engineering Division



SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:



JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

TABLE OF CONTENTS

Page

LETTER OF TRANSMITTAL

BRIEF ASSESSMENT

REVIEW BOARD SIGNATURE SHEET

PREFACE

TABLE OF CONTENTS

OVERVIEW PHOTO

LOCATION MAP

REPORT

SECTION 1 - PROJECT INFORMATION 1

SECTION 2 - ENGINEERING DATA 6

SECTION 3 - VISUAL INSPECTION 7

SECTION 4 - OPERATIONAL PROCEDURES 9

SECTION 5 - HYDRAULIC/HYDROLOGIC 10

SECTION 6 - STRUCTURAL STABILITY 12

SECTION 7 - ASSESSMENT, RECOMMENDATIONS,
AND REMEDIAL MEASURES 13

APPENDIX A - VISUAL INSPECTION CHECK LISTS

APPENDIX B - ENGINEERING DATA

APPENDIX C - INSPECTION PHOTOGRAPHS

APPENDIX D - HYDROLOGIC COMPUTATIONS

APPENDIX E - INFORMATION AS CONTAINED IN THE
NATIONAL INVENTORY OF DAMS



**EAST DIKE
ARLINGTON MILL RESERVOIR**

Salem, NH.

Approx. Scale 1" = 280'

PHASE I INSPECTION REPORT
EAST DIKE ARLINGTON MILL RESERVOIR

NH 00028

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Whitman & Howard, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to Whitman & Howard, Inc. under a letter of May 1, 1978 from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW33-78-C-0313 has been assigned by the Corps of Engineers for this work.

b. Purpose

- (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
- (2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
- (3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

- a. Location - Wheeler Dam is located in the Town of Salem, N.H. on the Spicket River, a tributary of the Merrimack River. It impounds the Arlington Mill Reservoir. The dam appears on the USGS quadrangle "Salem Depot, NH-Mass".
- b. Description of Dam and Appurtenances - Wheeler Dam is a concrete gravity dam with earth abutments, built upon ledge. The concrete portion is approximately 500 feet long with a maximum structure height of 54 feet. A 100 foot long spillway was built integrally with the main dam, with a crest elevation of 160 feet msl and a gross freeboard of 8 feet to the top of the dam. A 2 foot flash board system is employed. Discharge is controlled from a gate house atop the dam with manual controls for three 48" steel conduits at different elevations. These are two submerged intake portals which bring water from different depths. The total drainage area at the dam is 23.5 sq. mi., of which 17.1 sq. mi. is controlled thru the Big Island Pond Dam.
- c. Size Classification - The volume of impounded water and height of the dike place this project at the bottom end of the "Intermediate" class.
- d. Hazard Classification - If the East Dike were to fail or be overtopped, flow would travel east into Providence Hill Brook, then south, joining the Spicket River below Wheeler Dam. The Spicket River flows from there through the eastern part of Salem, past several residential developments, and thence through the urban areas of Methuen and Lawrence, Mass. The sluggish nature of the Spicket River Valley would dissipate the flood wave fairly rapidly but not before considerable damage was done. Some loss of life would probably occur. Although the dike is not as hazardous as Wheeler Dam due to a lower height (31 ft. vs. 54 ft.), it is placed in the same "Significant-to-High" classification.

- e. Ownership - Ownership and water rights are integral with Wheeler Dam. Present owner is the Spicket River Corp. of Lawrence, Mass. The dike has always been in the hands of the owners of the former Arlington Mills in Lawrence.
- f. Operator - Harlan Low
550 Broadway
Lawrence, Mass. 617/686-3846
- g. Purpose of Dam - The East Dike was built in conjunction with Wheeler Dam and the West Dike to create Arlington Mill Reservoir. The purpose was to store water and regulate flow for an industrial mill complex located on the Spicket River in Lawrence, Mass.
- h. Design and Construction History - The East Dike was built under the same contract as Wheeler Dam, and was completed in 1922. Chief engineer was H.K. Barrows of Boston, Mass.
- i. Normal Operational Procedure(s) - No operation as such.

1.3 Pertinent Data:

a. Drainage Areas

23.5 square miles of which 17.1 square miles are controlled at Big Island Pond Dam.

b. Discharge at Damsite

No discharge at East Dike - see Wheeler Dam report for discharge data of Arlington Mill Reservoir.

c. Elevation (ft. above MSL)

- (1) Top Dam - 169
- (2) Maximum pool-design surcharge - 166
- (3) Full flood control pool - N/A

- (4) Recreation pool - 160 (top of Wheeler Dam flashboards 162.1)
- (5) Spillway crest - No spillway
- (6) Upstream portal invert diversion tunnel - None
Downstream portal invert diversion tunnel - None
- (7) Streambed at centerline of dam - Approximately 138 (not a stream-low point in swale)
- (8) Maximum tailwater - No tailwater

d. Reservoir

- (1) Length of maximum pool - Approximately 11,000 feet
- (2) Length of recreation pool - Approximately 9,600 feet
- (3) Length of flood control pool - N/A

e. Storage (acre-feet) - Not counting dead storage

- (1) Recreation Pool - 3,300 (@ elev. 160)
- (2) Flood Control Pool - N/A
- (3) Design Surcharge - 5,000 (@ elev. 166)
- (4) Top of Dam - 5,940 (@ elev. 169)

f. Reservoir Surface (acres)

- (1) Top Dam - Estimated 320 acres
- (2) Maximum pool - Estimated 300 acres
- (3) Flood-control pool - N/A
- (4) Recreation pool - Measured 266 acres @ elev. 160

(5) Spillway crest - N/A

g. Dam

(1) Type - Earth embankment with concrete core wall on ledge

(2) Length - 530 ft.

(3) Height - Maximum height 31 ft.

(4) Top Width - 11'

(5) Side Slopes - Upstream 3:1, Downstream 2-1/2:1

(6) Zoning - According to designer's report, upstream embankments of "impervious earth fill carefully rolled" - downstream embankments "of less carefully selected material but well compacted".

(7) Impervious Core - Concrete core wall on ledge

(8) Cutoff - Concrete core wall on ledge

(9) Grout curtain - N/A

h. Diversion and Regulating Tunnel - None

i. Spillway - None

j. Regulating Outlets - None

SECTION 2: ENGINEERING DATA

2.1 Design

The East Dike designed as a fairly simple embankment with concrete core wall built upon ledge. According to the designer's report, the upstream embankment is of "impervious earth fill, carefully rolled", downstream embankment of "less carefully selected material but well compacted". See paragraph 1.2b and plate in Appendix B.

2.2. Construction

Photos and inspector's reports verify that the dike was constructed in a configuration according to the plans. Degree of compaction, soil and concrete analyses are, however, unknown.

Project was part of the Wheeler Dam job, and was generally carried out in a professional manner.

2.3 Operation

No operation as such.

2.4 Evaluation

- a. Availability - Set of construction plans (not very detailed), designer's report, inspection reports, and many photos are available from owner and NH Water Resources Board.
- b. Adequacy - Good. Major features well known - details skimpy.
- c. Validity - Good.

SECTION 3: VISUAL INSPECTION

3.1 Findings

- a. General - No serious problems were detected.
- b. Dam - The crest of the dam is covered with grass and there is a footpath worn bare along the entire length of the crest.

The upstream slope is covered with riprap in generally good condition. There are a small clump of birch trees and a few 4- to 5-inch diameter stumps on the upstream slope near the southeast abutment, but the upstream slope is otherwise clear of brush and trees.

The downstream slope of the dam is covered with brush and trees, some of which are quite large.

From about 135 to 250 feet southeast of the northwest abutment there is an area of marsh-like grass, the upper limit of which was about 3 feet below the level of the water in the reservoir at the time of the inspection. The ground was not noticeably wet or spongy where this grass was growing at the time of the inspection. One footpath (or possibly a motorcycle path) has been worn bare between the toe and crest of the downstream slope.

Two docks have been built adjacent to the upstream slope of the dike. At the southeast abutment, the contact with the upstream face is only sparsely vegetated and appears to have been used for boat launching.

Immediately downstream of the dam the ground is wet and soggy locally, but there was no evidence of seepage discharging at the time of the inspection and it was possible to walk on foot everywhere.

One filled-in hole which appears to have been an animal burrow, was seen on the downstream face.

- c. Appurtenant Structures - N/A

- d. Reservoir Area - Cottage development extensive
- e. Downstream channel - N/A

3.2 Evaluation

There is no evidence from the visual examination that the dike is unstable.

Trespassing has led to the development of a bare path along the crest of the dam, another bare path from the crest to the toe of the downstream slope, and a sparsely vegetated area at the contact between the upstream slope and the southeast abutment. There is also an extensive growth of brushes and trees on the downstream slope, and evidence (in the form of moisture-loving vegetation) that seepage may be discharging on the downstream slope about 3 feet below the reservoir level at the time of the inspection. These conditions could lead to future problems if not remedied.

SECTION 4: OPERATIONAL PROCEDURES

- 4.1 Procedures - No operation as such.
- 4.2 Maintenance of Dam - Occassional observation and clean-up visits.
- 4.3 Maintenance of Operating Facilities - N/A
- 4.4 Description of any warning system in effect - None
- 4.5 Evaluation - Trees should not have been allowed to grow so large. Trespass should be discouraged more vigorously.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

Hydraulically, the East Dike is part of Wheeler Dam. The top elevation of the East Dike is the same as for the earth embankments of Wheeler Dam (169). No hydraulic design criteria is known for Wheeler Dam.

b. Experience Data

There is no history of overtopping, and no such visual evidence. It is highly unlikely that an overtopping would have gone unreported.

c. Visual Observations

There is nothing to observe from a hydraulic standpoint.

d. Overtopping Potential

Since the East Dike is effectively a part of Wheeler Dam, the overtopping potential is identical. The following section is verbatim from the Wheeler Dam Phase I report.

Reference is made to Appendix D for the hydrologic computations performed as a part of this report.

The peak inflow into Arlington Mill Reservoir of the Probable Maximum Flood (PMF) is computed to be about 22,300 cfs. The PMF is defined as the largest flood that can reasonably be expected to occur on a given stream at a selected point, or the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

For structures of the size and hazard classification of Wheeler Dam, the "test flood" is generally selected as the full PMF. The test flood is that flood used to evaluate the hydraulic adequacy of a project. The test flood for Wheeler Dam is chosen as the full PMF.

If the upstream Big Island Pond Dam were to remain intact during the test flood condition, the peak inflow into Arlington Mill Reservoir would be reduced from 22,300 cfs to about 17,000 cfs, due to the surcharge storage effect in Big Island Pond. However, it has been determined that Big Island Pond Dam will likely fail under flows well below this test flood. (See Phase I report for Big Island Pond Dam, NH 00470.) Therefore, the evaluation of the hydraulic adequacy of Wheeler Dam should not rely upon the surcharge effect of Big Island Pond.

Assuming Wheeler Dam remains intact, the peak outflow during the test flood would be about 19,800 cfs, the reduction from the inflow of 22,300 cfs being accounted for by the surcharge storage effect of Arlington Mill Reservoir. At the moment of this peak outflow, the water surface would be about 170.3 ft. msl or 1.3 ft above the top of the earth embankments of Wheeler Dam and also those of the East Dike and West Dike.

The spillway capacity of Wheeler Dam, including the capacity of the three discharge conduits and also the extra capacity of one foot of flow over the main concrete portion, is computed to be about 12,600 cfs, or 64% of the peak outflow during the test flood. Overtopping potential is judged as moderate.

It must be mentioned that should Big Island Pond Dam fail suddenly in the later stages of a severe flood (after building up a large hydraulic head) the impact of the resulting flood wave could wipe out Wheeler Dam and the two dikes.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual Observations - There is no evidence of settlement, cracks, boils or other structural problems. Minor areas of dampness should be checked in future routine inspections.
- b. Design and Construction Data - The evidence indicates that the dike was professionally designed and well built.
- c. Operating Records - N/A
- d. Post Construction Changes - Trees and shrubs have grown extensively on the downstream face. Also, a small diameter plastic water pipe, of unknown depth and backfill, has been trenched through the top of the northwest abutment. A change such as this can lead to piping through the dam if the water level rises above the bottom of the trench.
- e. Seismic Stability - This dike is in Seismic Zone 2 and hence does not have to be evaluated for seismic stability according to the OCE Recommended Guidelines.

SECTION 7: ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition - The East Dike is in overall good to fair condition, although a number of actions should be undertaken as outlined below.
- b. Adequacy of Information - Fair to good. Principal features well known, although details are lacking.
- c. Urgency - The recommendations and remedial measures should be carried out within 1 to 2 years.
- d. Necessity for Additional Investigations - Definitely no necessity. However, if Arlington Mill Reservoir is drained to inspect Wheeler Dam, it is recommended that the East Dike be inspected briefly before refilling of the reservoir.

7.2 Recommendations

The owner should:

- a. Retain a competent engineer to investigate the apparent seepage.
- b. Cut all trees on the upstream and downstream faces and retain a competent engineer to supervise the removal of trees, roots and replacement with proper backfill.
- c. Order the removal of the water pipe mentioned in the report and retain a competent engineer to specify a proper backfill after removal of the pipe.
- d. Order the removal of the docks.

7.3 Remedial Measures

a. Alternatives - N/A--

b. Operation & Maintenance Procedures

- (1) The dike should henceforth be kept clear of all trees and shrubs. A dense growth of grass should be maintained.
- (2) A more conscientious method of preventing trespass should be adopted.
- (3) It is recommended that the owner adopt a program of regular observation visits by a responsible individual. Visits should be at least weekly and a permanent log kept.

EAST DIKE
APPENDICES

<u>Appendix</u>	<u>Description</u>
A	Visual Inspection Checklist - 3 pp.
B	Engineering Data
C	Inspection Photographs with Index - 8 Photographs
D	Hydrologic Computations
E	Information as Contained in the National Inventory of Dams

APPENDIX A
VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT East Dike
Arlington Mill Reservoir

DATE June 7, 1978*

TIME 11:00 AM

WEATHER sunny - warm

W.S. ELEV. 162.2 U.S. none DN.S.

PARTY:

- | | |
|--------------------------------|-----------|
| 1. <u>T.T. Chiang, W&H</u> | 6. _____ |
| 2. <u>J. Scott, W&H</u> | 7. _____ |
| 3. _____ | 8. _____ |
| 4. _____ | 9. _____ |
| 5. _____ | 10. _____ |

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Entire Dike</u>	<u>Chiang & Scott</u>	
2. _____	_____	_____
3. _____	_____	_____
4. _____	_____	_____
5. _____	_____	_____
6. _____	_____	_____
7. _____	_____	_____
8. _____	_____	_____
9. _____	_____	_____
10. _____	_____	_____

*Second inspection performed - see next sheet
Check list combines observations of both inspections

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT East Dike
Arlington Mill Reservoir

DATE June 28, 1978*

TIME 11:00 AM

WEATHER sunny - hot

W.S. ELEV. 162.0 U.S. none DN.S.

PARTY:

- | | |
|---------------------------------------|-------------|
| 1. <u>J. Scott, W&H</u> | 6. <u></u> |
| 2. <u>R. Hirschfeld, Geotechnical</u> | 7. <u></u> |
| 3. <u>Engineers, Inc.</u> | 8. <u></u> |
| 4. <u></u> | 9. <u></u> |
| 5. <u></u> | 10. <u></u> |

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Entire dike</u>	<u>Scott & Hirschfeld</u>	<u></u>
2. <u></u>	<u></u>	<u></u>
3. <u></u>	<u></u>	<u></u>
4. <u></u>	<u></u>	<u></u>
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9. <u></u>	<u></u>	<u></u>
10. <u></u>	<u></u>	<u></u>

*Second inspection - see previous sheet for first inspection details.
Check list combines observations of both inspections.

PERIODIC INSPECTION CHECK LIST

PROJECT East Dike
 Arlington Mill Reservoir

DATE 6/7/78 & 6/28/78

PROJECT FEATURE Entire Dike

NAME Entire party

DISCIPLINE _____

NAME _____

AREA EVALUATED	CONDITION
<u>DIKE EMBANKMENT</u>	
Crest Elevation	OK
Current Pool Elevation	162.2 on 6/7; 162.0 on 6/28
Maximum Impoundment to Date	Unknown
Surface Cracks	None
Pavement Condition	No pavement
Movement or Settlement of Crest	None
Lateral Movement	None
Vertical Alignment	OK
Horizontal Alignment	OK
Condition at Abutment and at Concrete Structures	No concrete structures. Good condition at abutments, except for trespassing and sparseness of vegetation at southeast abutment. Many trees cover downstream slope, some quite large. Small trees on upstream face cut recently.*
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	No structural items
Sloughing or Erosion of Slopes or Abutments	Footpath on downstream face. Two boat docks (temporary). None
Rock Slope Protection-Riprap Failures	Riprap in good shape - well placed.
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	Wet spot past toe at low point - probably surface drainage, not seep. Area of wet-type grass starting at elev. 159#, from 135 ft. to 250 ft. from northwest abutment
Piping or Boils	None
Foundation Drainage Features	None
Toe Drains	None
Instrumentation System	None

*Plastic water line dug thru top of abutment - shallow. Also small area of fill at NW abutment (for parking area? one car)

APPENDIX B
EAST DIKE
ENGINEERING DATA

Plate - Plan and Section

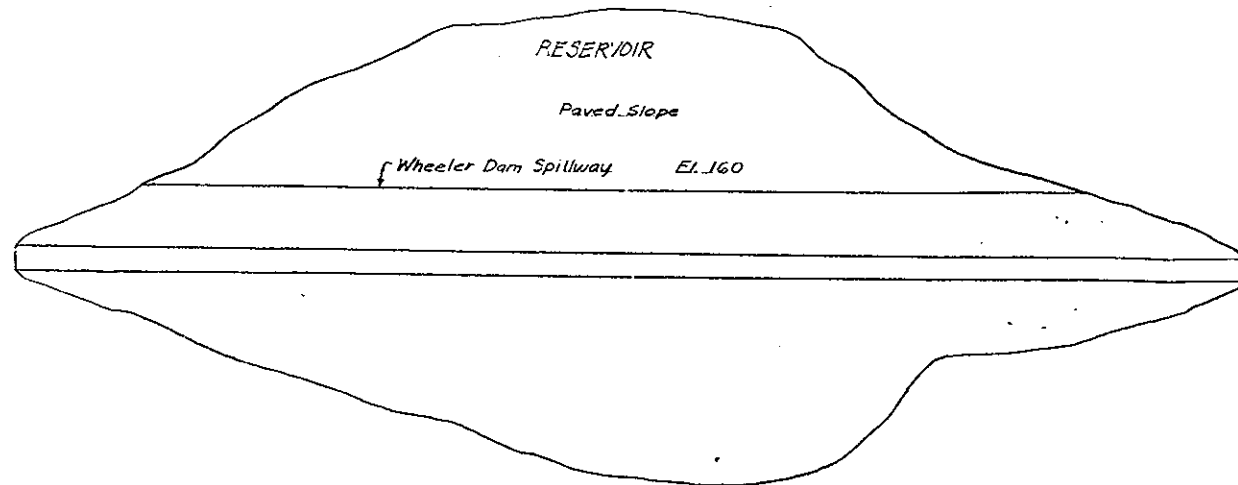
N.H. Water Resources Board letter to owner, 2/24/75

N.H. Water Resources Board Dam Safety Inspection Form
Form, 12/13/73

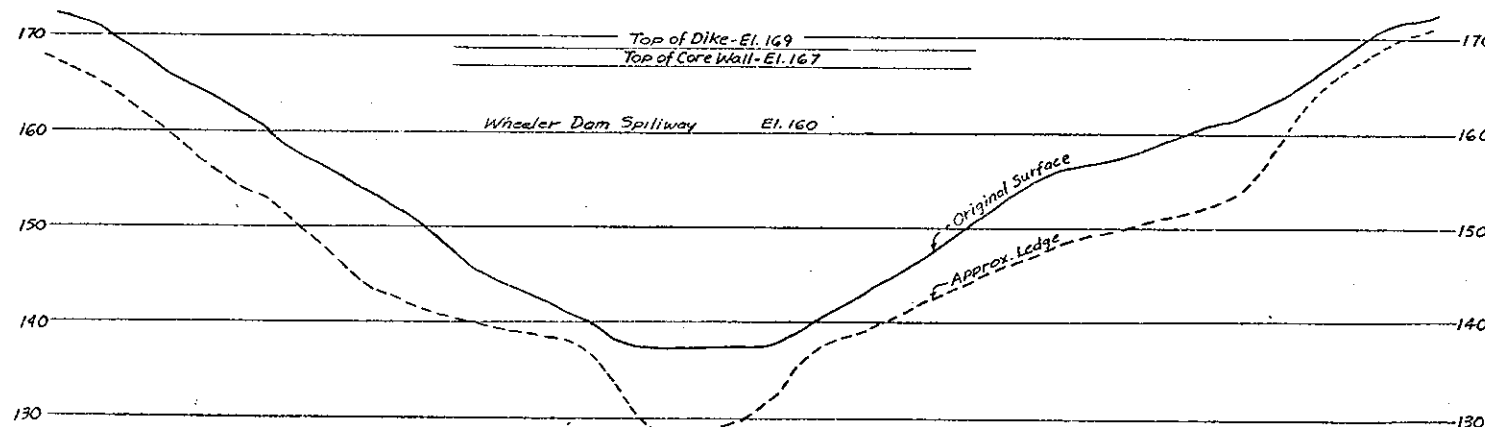
Photograph, 10/30/35

Construction photograph, 11/16/21.

Chief Engineer's Design Memorandum, 7/31/20

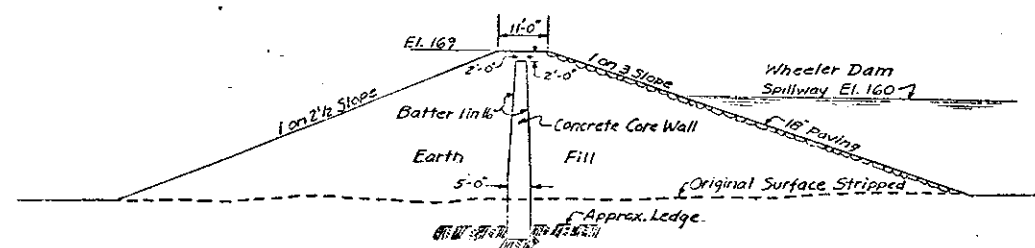


PLAN



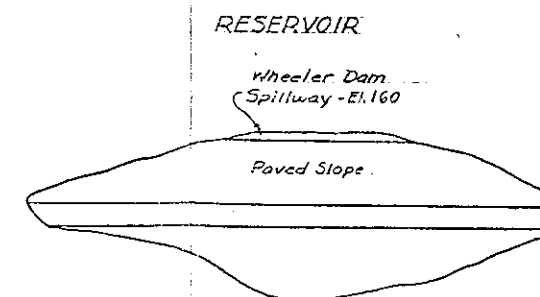
PROFILE

HORIZ. SCALE IN FEET
 40 20 0 40 80 120
 VERT. SCALE 4:1 EXAGGERATION

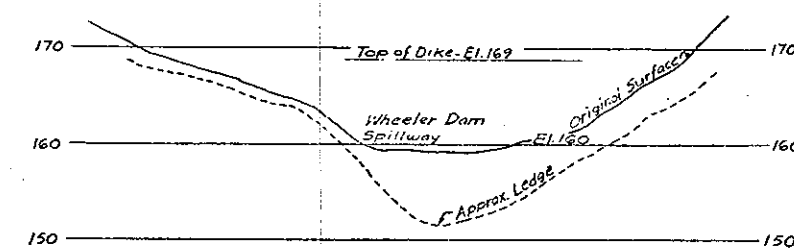


EAST DIKE

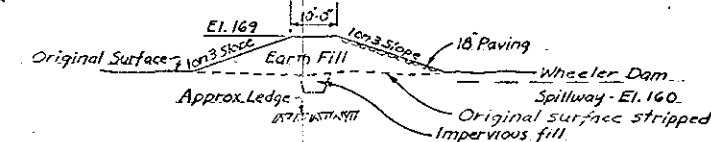
HORIZ. SCALE IN FEET
 20 10 0 20 40 80



PLAN



PROFILE



TYPICAL SECTION

WEST DIKE

NOTE: Paved roadway across crest. Upstream face filled out with beach sand to approx. 1 on 6 slope.

Job No. 8-081 Job No. 8-083

Traced from original plans dated July 1920, modified to suit.

All elevations are USGS mean sea level datum.

WHITMAN & HOWARD INC. ENGINEERS AND ARCHITECTS WHEELSLEY, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WHEELSLEY, MASS.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
EAST AND WEST DIKES ARLINGTON MILL RESERVOIR	
SICKETT RIVER	NEW HAMPSHIRE
SCALE	AS SHOWN
DATE	JULY, 1978

Greater Lawrence Industrial Corporation
550 Broadway
Lawrence, MA 01840

RE: REQUIRED REPAIRS TO THE FOLLOWING DAMS:

Dam #209.02 (Taylor Dam)

1. Repair abutments.
2. Repair badly eroded floor of chute spillway.

Dam #209.04 (Dike)

1. Remove trees which have started growing on dike.

Dam #209.05 (Wheeler Reservoir)

1. Repair leakage through dam located near gate house.
2. Repair spalling concrete before it becomes critical.

Dam #209.08 (Millville)

1. Repair badly spalled and cracked abutments.
2. Repair leakage at location where new concrete has been added (Left spillway).
3. Remove trees and brush from downstream toe and dike.
4. Replace left gate stem.

Dam #209.09 (Canobie Lake)

1. Repair spillway - walls show signs of deterioration.
2. Remove trees from embankment.

zd/js

N. H. WATER RESOURCES BOARD
Concord, N. H. 03301

DAM SAFETY INSPECTION REPORT FORM

Town: SALEM Dam Number: 209.04

Inspected by: _____ Date: 12-13 1973

Local name of dam or water body: _____

Owner: SPICKETT RIVER CORP Address: _____

Owner ~~was~~ was not interviewed during inspection.

Drainage Area: _____ sq. mi. Stream: _____

Pond Area: _____ Acre, Storage _____ Ac-Ft. Max. Head _____ Ft.

Foundation: Type EARTH, Seepage present at toe - Yes ☒ No ☐

Spillway: Type NONE, Freeboard over perm. crest: _____

Width _____, Flashboard height _____

Max. Capacity _____ c.f.s.

Embankment: Type _____, Cover RIPPRAP Width _____

Upstream slope _____ to 1; Downstream slope _____ to 1

Abutments: Type NONE, Condition: Good, Fair, Poor

Gates or Pond Drain: Size NONE Capacity _____ Type _____

Lifting apparatus _____ Operational condition _____

Changes since construction or last inspection: _____

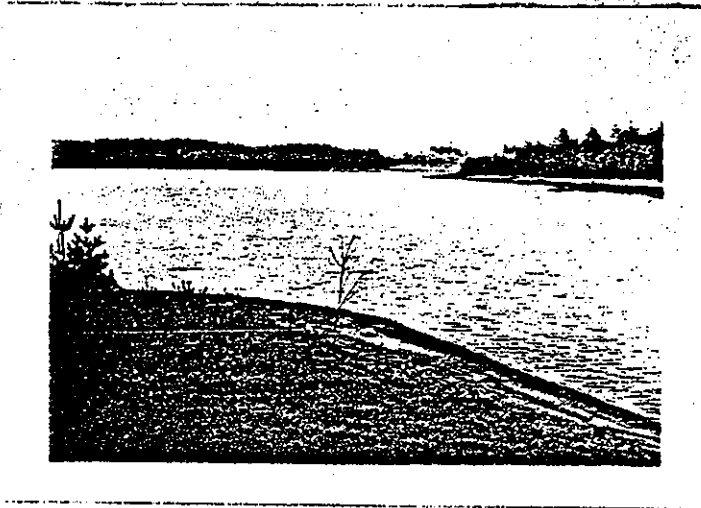
Downstream development: _____

This dam would would not be a menace if it failed.

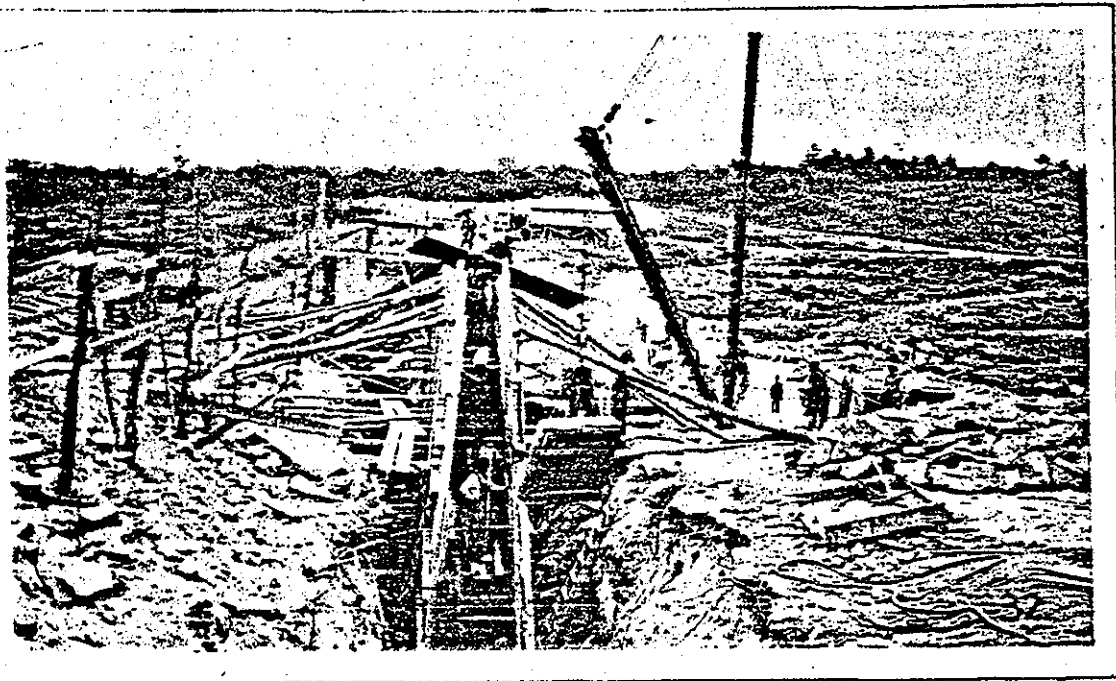
Suggested reinspection date: _____

Remarks: SHOULD REMOVE TREES SEEN UPSTREAM &
DOWNSTREAM FACES

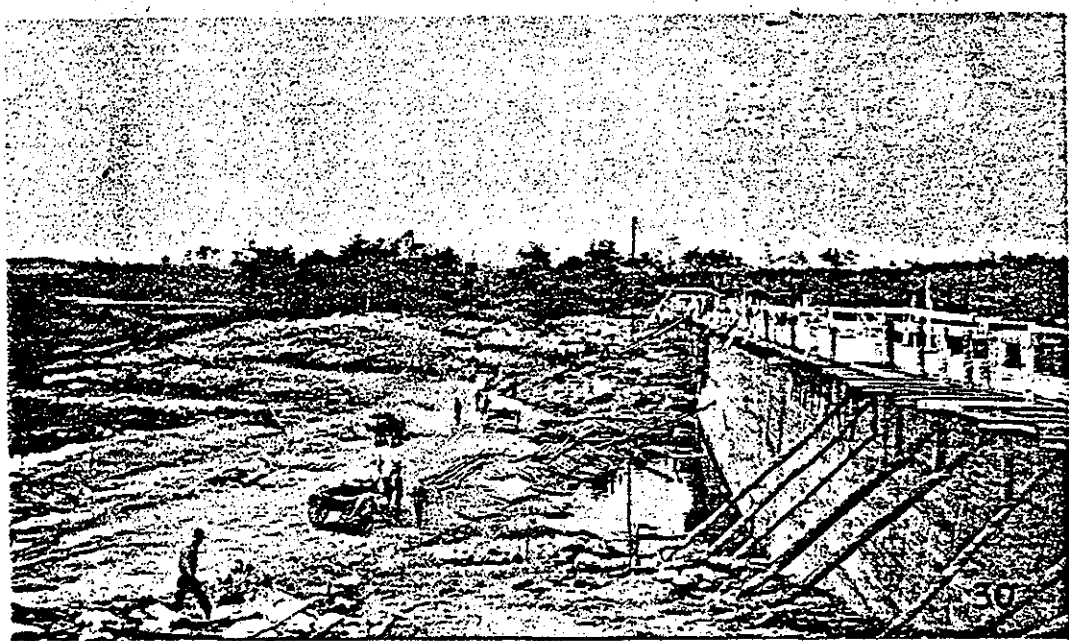
SPICKETT RIVER IN SALEM
Arlington Mills
October 30, 1935



ARLINGTON MILLS RESERVOIR
SALEM



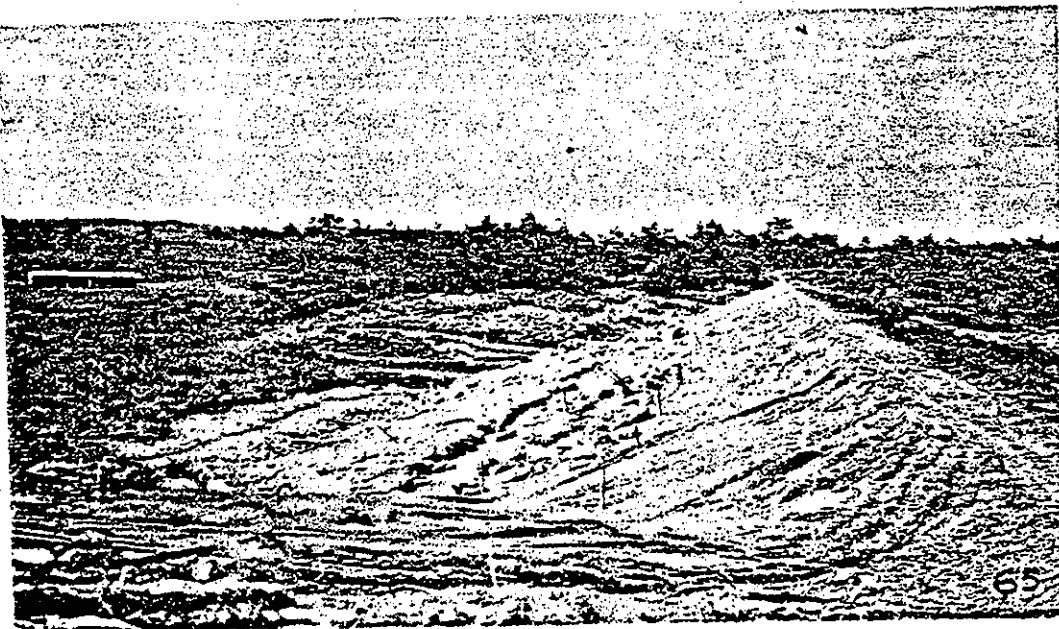
East
Dike



East
Dike

East
Dike

ARLINGTON MILLS RESERVOIR
SALEM



ARLINGTON MILLS WATER SUPPLY

WHEELER RESERVOIR

Memorandum by H. K. Barrows, July 31, 1920,
accompanying letter to M.H. Public
Service Commission.

WHEELER RESERVOIR

The general extent of this reservoir is shown on sheet 1019.45. It is located on Spicket River in the town of Salem and will extend from the vicinity of Wheeler's Mill (burned a number of years ago and not rebuilt) to North Salem - a distance of about 1.5 miles. The drainage area of Spicket River tributary to this reservoir will be about 22 square miles.

As planned, the level of the permanent spillway of the main dam will be at elevation 160 (datum approximate mean sea level) and the capacity of the reservoir when drawn to elevation 140 will be about 1,000 million gallons. The elevation of the present mill pond at the old Wheeler Mill is about 133. As noted farther, it is planned to arrange the spillway of the main dam so that 1 ft. flashboards can be carried if desired, which will increase the capacity of the reservoir above elevation 140 to a total of about 1,100 million gallons.

The water area of the reservoir at elevation 160 will be about 270 acres.

CONSTRUCTION REQUIRED

In addition to the main dam near the old Wheeler Mill, there will be required two dikes at low places in the watershed. These are shown on sheet 1019.47 as the East and West Dikes respectively.

Borings and test pits have been made and ledge rock located at both dam and dike sites.

As will be noted, a section of the highway leading from Salem to North Salem is to be discontinued and in lieu of this a new road constructed lying easterly from the East Dike and connecting with existing roads, which are also to be reconstructed. The highway at North Salem will also have to be raised for a few hundred feet, and at at least one other point on the highway adjacent to the reservoir a slight fill made. These changes were authorized by the Town of Salem on July 10, 1920.

MAIN DAM

Details of the main dam are shown on sheet 1019.46. Its total length will be about 730 feet, consisting of a 100 ft. spillway at El. 160, and about 380 ft. of bulkhead section, all of concrete. The interior portion of the concrete will be in the proportion of 1-3-6, with occasional large stones embedded in the concrete. The exterior portion of the concrete are to be in the proportion of 1-2½-4. The remaining portion of the dam at each end will consist of earth fill with concrete core wall, the concrete to be 1-3-6.

The maximum height of the spillway section is about 28 ft. above ledge rock with crest at El. 160, arranged so that 12 inch wooden flashboards can be carried by wrought iron pins. The latter are proportioned so that they will bend over and the flashboards go out if the head of water on the crest of the dam reaches 4 ft.

The bulkhead section will have a maximum height above bed rock at the present river bed of about 53 ft. The bulkhead section for a length of 160 ft. near its highest portion will be curved upstream in plan, with a radius, on the downstream side, of about 665 ft.

In the bulkhead section is to be a gate house through which will run three 48 inch steel pipes set in the concrete of the dam, each arranged with a 48 inch circular sluice gate with gate control and lift in the gate house at the top of the dam. The westerly pipe is intended for power use of water, is to be arranged with racks and can be later extended down stream a short distance to a suitable power house location. The other two 48 inch pipes are intended for use in releasing water from the reservoir.

Never
← done

DIKES (See sheet 1019.47)

East Dike

The East Dike will be about 530 ft. long constructed of earth fill with concrete core wall. The top of the dike will be at El. 169, the top of core wall 167. The upstream

half of the dam is to be of impervious earth fill carefully rolled, the downstream half of less carefully selected material but well compacted. The concrete core wall is to be in the proportion of 1-3-6 and to extend into ledge or impervious foundation. Further details are shown on the plan.

The maximum height of the East Dike above the present surface is about 31 ft.

West Dike

As will be noted by reference to sheet 1019.47, this is a low structure, the present ground level being only a little below El. 160 at the middle of the dike location. The maximum height of the dike with top at El. 169 is about 10 ft. This will be of earth fill, as noted on the plan, but without concrete core.

APPENDIX C
EAST DIKE
INDEX TO INSPECTION PHOTOGRAPHS

<u>Photo No.</u>	<u>Description</u>
1	Upstream face of dam looking southeast from northwest abutment.
2	Photo taken from southeast abutment, showing two docks (one partially hidden behind trees), a clump of birch trees on the upstream face of dike near southeast abutment, crest of dike with footpath along crest, cable and damaged gate across crest, and tree-covered downstream slope with evidence of recent clearing of downstream slope near abutment (in foreground).
3	Several tree stumps, about 4 to 5 inches in diameter (one to right of metal clipboard), near crest of upstream slope close to southeast abutment, as viewed from edge of reservoir.
4	Upstream slope of dike looking toward northwest abutment, showing riprap. Brush has been cleared from upstream slope.
5	Plastic water pipe near northwest abutment, which is laid above ground up to the top of the riprap on the upstream face and below ground across the crest to a camp north of the northwest abutment.
6	Photo taken from low point of channel downstream of dam looking toward northwest abutment. Large trees and brush growing on downstream slope. Vegetation characteristic of wet areas growing downstream of toe of dike. (Valley downstream of toe is wet and soggy locally, but there was no evidence of seepage discharging at the time of the inspection and it was possible to walk on foot everywhere.)

Photo No.

Description

- | | |
|---|---|
| 7 | Looking up the downstream slope from a point at the toe of slope showing a foot-path (motorcycle path?) that runs up the slope. Metal clipboard is lying on the path. |
| 8 | Filled-in hole, which appears to have been an animal burrow, on the downstream face of the dike. |



1



2



3



4



5



6



7



8

APPENDIX D
HYDROLOGIC COMPUTATIONS
WATERSHED MAP

APPENDIX D

BY T. J. C. DATE Aug 22 PROJECT Army Corps Engs SHEET NO. 1 OF 7
 CHKD. BY _____ DATE _____ Dam Safety Inspection JOB NO. 8-081, 082, 083

Arlington Mill Reservoir	East Dike	1922	31'
	Wheeler Dam	1917	32'
	West Dike	1922	10'

I. Hydrology & Hydraulic Data.

a) Drainage Area: At Dam site D.A. is 23.5 sq. mile include Big Island Pond D.A. of 16.7 sq. mile

b) Watershed Characteristics.

River channel slope ≈ 0.0288 — Major Drainage Area.

Side drainage area slope West ≈ 0.048

East ≈ 0.052

Big Island Pond discharges into Arlington Mill Reservoir, within a 23.5 sq. mile drainage area there are both good sized reservoirs. Therefore the Basin should be classified as flat-tolling-land type.

c) Water surface Area = 266 Acres at El. 160 \pm (Spillway crest Elevation.)

d) Storage Capacity: Based on N.H. Water Resources Board's storage for the top 20 ft is about 3030 Acre-ft. Usually the Drawdown curve start at spillway crest. The top five feet has storage capacity of 1200 Acre-ft, therefore, the estimated maximum storage should be about 5400 Acre-ft, (Normal storage would be about 3400 Acre-ft.) This assumes that water surface would reach top of the concrete portion of the dam (El. 163) and the spillway crest (El. 160) respectively.

Therefore, All three embankments (Wheeler Dam, East Dike, West Dike) should be classified as intermediate dam category.

e) Probable Max. Flood Flow. Based on D.A. = 23.5 sq. mile

Estimated Peak PMF for Rolling Land = 1400 cfs/sq. mile D.A.
 " " Flat Area = 600 cfs/sq. mile D.A.
 Average = 950 cfs/sq. mile D.A.
 Peak PMF = $950 \times 23.5 = 22,325$ cfs

f) Existing Spillway Capacity. Neglecting wave action

Top of Earth embankment at El. 169
 Top of Concrete Gravity Dam at El. 168
 Spillway crest Elev. 160
 Spillway length (Ogee Section) 100 ft

Spillway max. Capacity when water at Top of Dam (El. 168)
 $= 3.8 \times 100 \times 8^{3/2} = 8600$ cfs

But the concrete gravity section of Dam can be overtopping at about 1 ft during emergency; thus the peak spilling capacity

$$= 3.8 \times 100 \times 9^{3/2} + 335 \times 3.0 \times 1^{3/2}$$

$$= 10260 + 1005 = 11,265 \text{ cfs} \leq \frac{1}{2} \text{ Peak PMF}$$

There are 3 - 4' diameter gates, only one operatable at present, the other two have not been operated for long time. Assume all three can be fixed and operated and use it as emergency spillway. the capacity of the 3 gates is:

$$Q = \sqrt{\frac{4.0}{1.75}} \times 2.03 \times (3 \times 4 \times 3.14) = 1450 \text{ cfs} \text{ When tailwater lower than outlet.}$$

This would bring the total emergency spillway capacity to about 12,600 cfs.

g) Discharge Flow Rating Curve.

The total length of earth embankments including main Dam, West Dike and East Dike is about 9000 ft in length. Treat it as a broad Crested Weir with discharge

Coefficient of 2.7 (Usually $C = 2.67$ to 3.05 for broad crested weir).

For water surface at level 1 ft above the top of earth embankment, discharge flow rate would be

$$Q = 3.8 \times 100 \times 10^{3/2} + 335 \times 3.0 \times 2^{3/2} + 1010 \times 2.67 + 1450$$

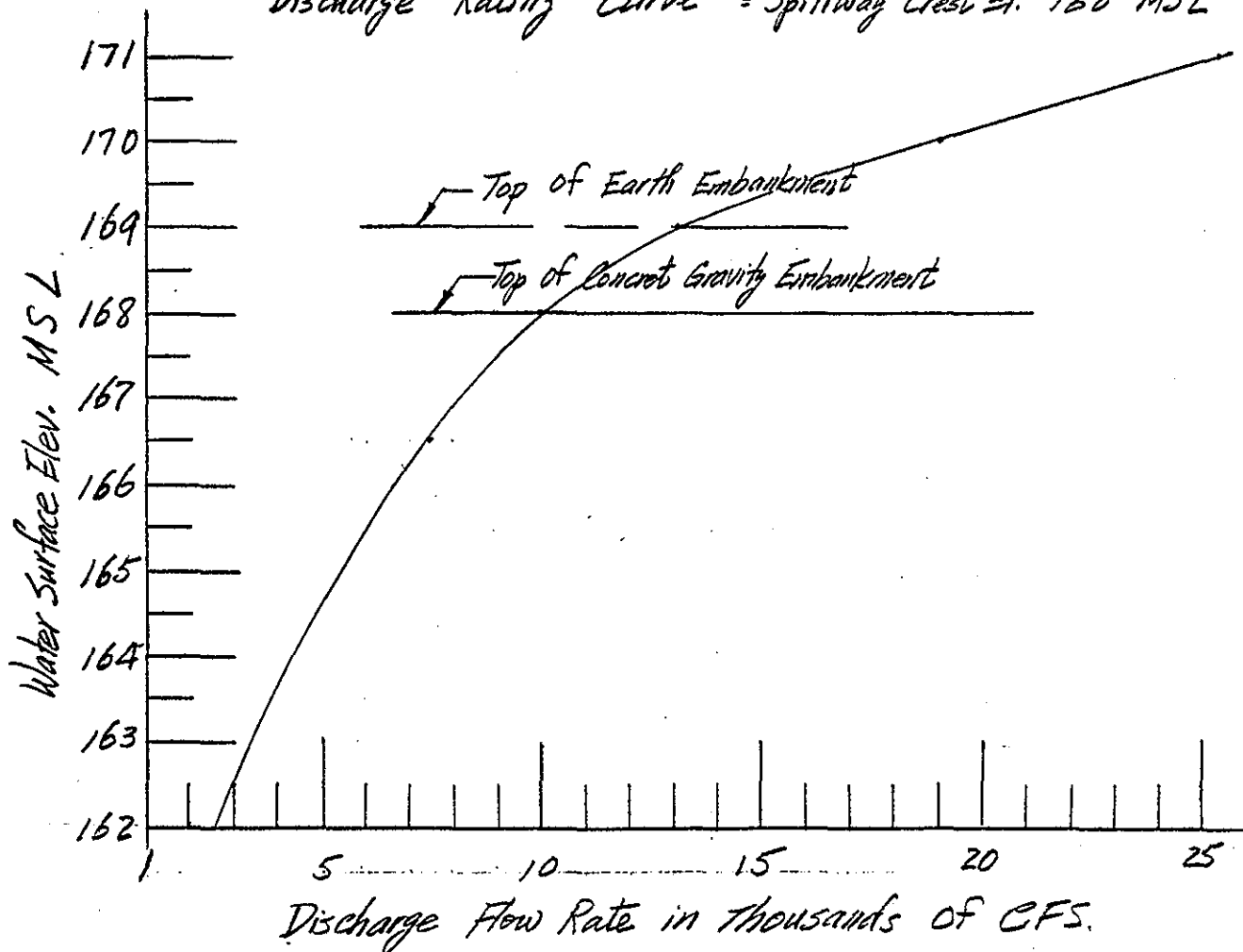
$$= 12,016 + 2843 + 2697 + 1450 = 19,006 \text{ cfs}$$

For water surface at level 2 ft above the top of earth embankment, discharge flow rate would be

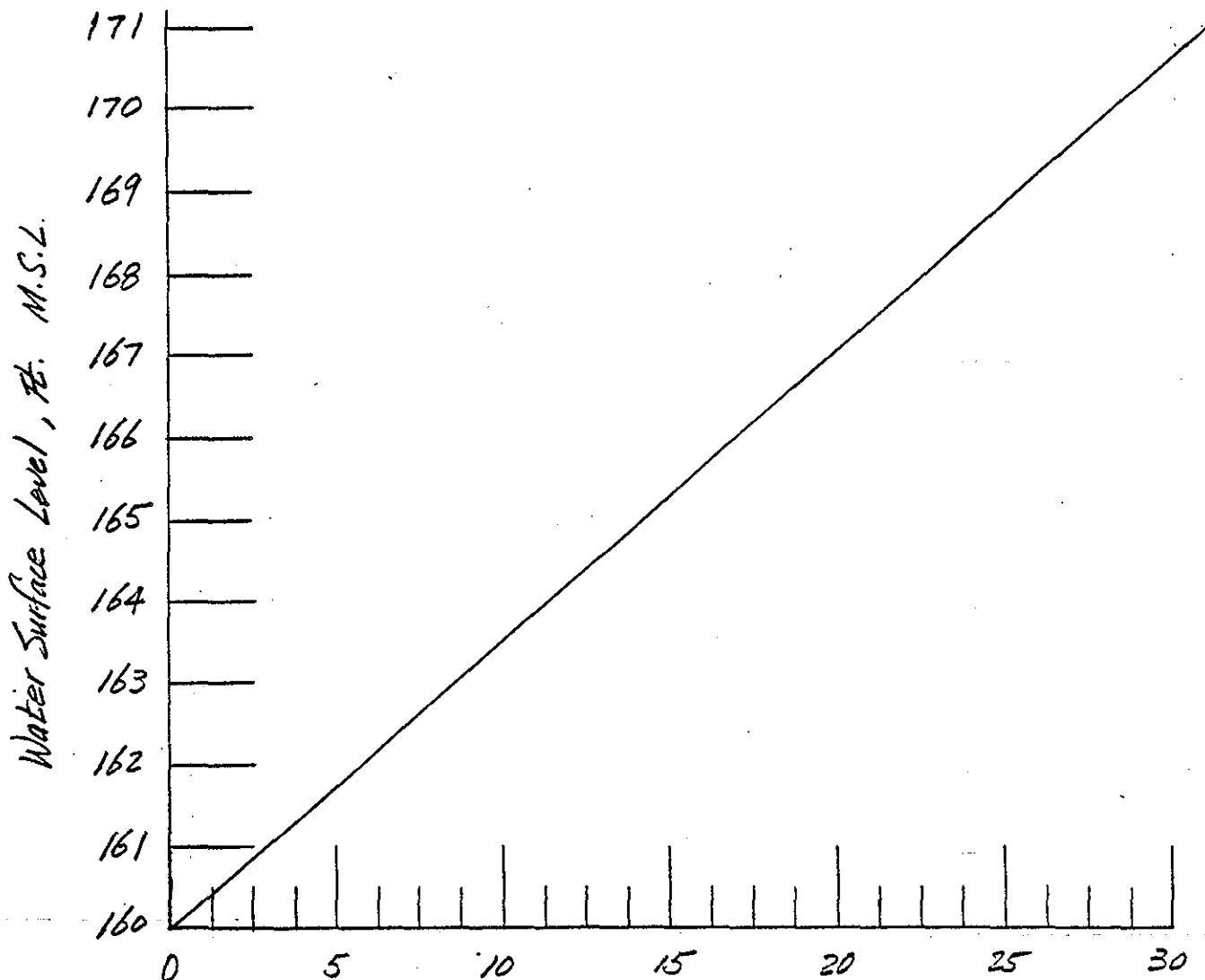
$$Q = 12,016 (1.1)^{3/2} + 2843 \left(\frac{3}{2}\right)^{3/2} + 2697 (2)^{3/2} + 1450$$

$$= 13863 + 5223 + 4800 + 1450 = 25336 \text{ cfs}$$

Discharge Rating Curve = Spillway Crest El. 160 MSL



h) Surge Capacity (= Water Surface Area x Surge depth)
 and its effect



Surge Capacity, Hundred Acre-ft

For $Q_{P1} = 22,330$ cfs from discharge rating curve

$$H_1 = 170.5 - 160 = 10.5 \text{ ft}$$

$$\text{STOP}_1 = 10.5 \times 266 \times 1.562 \times 10^{-3} \times 12 / 23.5 \\ = 2.228 \text{ inch}$$

$$Q_{P2} = Q_{P1} (1 - 2.228 / 19) = 19,685 \text{ cfs}$$

$$H_2 = 17.2 - 160 = 10.2 \text{ ft}$$

$$\text{STOP}_2 = 2.228 \left(\frac{10.2}{10.5} \right) = 2.164 \text{ inch}$$

$$\text{STOP}_{\text{ave}} = (2.164 + 2.228) / 2 = 2.196 \text{ inch}$$

$$QP3 = QP1 \left(1 - \frac{2.196}{19}\right) = 19,749 \text{ cfs}$$

$\therefore H = 170.3 - 160 = 10.3 \text{ ft}$ About 1.3 ft overtopping the earth embankment

i) Consider Big Island Pond Surge Effect.

If Big Island Pond Dam does NOT Fail at peak PMF then, the discharge from Big Island Pond amount to 10,500 cfs.

$$\text{Peak inflow from addition watershed} = 950(23.5 - 16.7) = 6500 \text{ cfs}$$

$$\text{Total peak inflow rate} = 17000 \text{ cfs}$$

$$\text{Then by discharge rating curve, } H_1 = 169.7 - 160 = 9.7 \text{ ft}$$

$$STOP1 = 9.7 \times 266 \times 1562 \times 10^{-3} \times 12 / 23.5 = 2.06 \text{ inch}$$

$$QP2 = 17000 \left(1 - \frac{2.06}{19}\right) = 15159 \text{ cfs}$$

$$H_2 = 169.4 - 160 = 9.4 \text{ ft}$$

$$STOP2 = 9.4 \times 2.06 / 9.7 = 2.0 \text{ inch}$$

$$STOP_{Ave} = \frac{STOP1 + STOP2}{2} = 2.03 \text{ inch}$$

$$QP3 = 17000 \left(1 - \frac{2.03}{19}\right) = 15184 \text{ cfs, say } 15200 \text{ cfs.}$$

$H = 169.4 - 160 = 9.4 \text{ ft}$ about 0.4 ft. overtopping the earth embankments (including dikes)

For any earth embankment, it should never be overtopped, especially without considering the wave effect. Therefore, increase the spillway length is necessary.

j) Improvement.

Assume an additional spillway at elevation 1.5 ft higher than the existing spillway crest with length of 50 ft. Then when water level at the top of concrete section of the dam, the total spillway capacity would be

$$Q = 10260 + 3.8 \times 100 \times 7.5^{3/2} + 1450 \\ = 10260 + 7805 + 1450 = 19515 \text{ cfs}$$

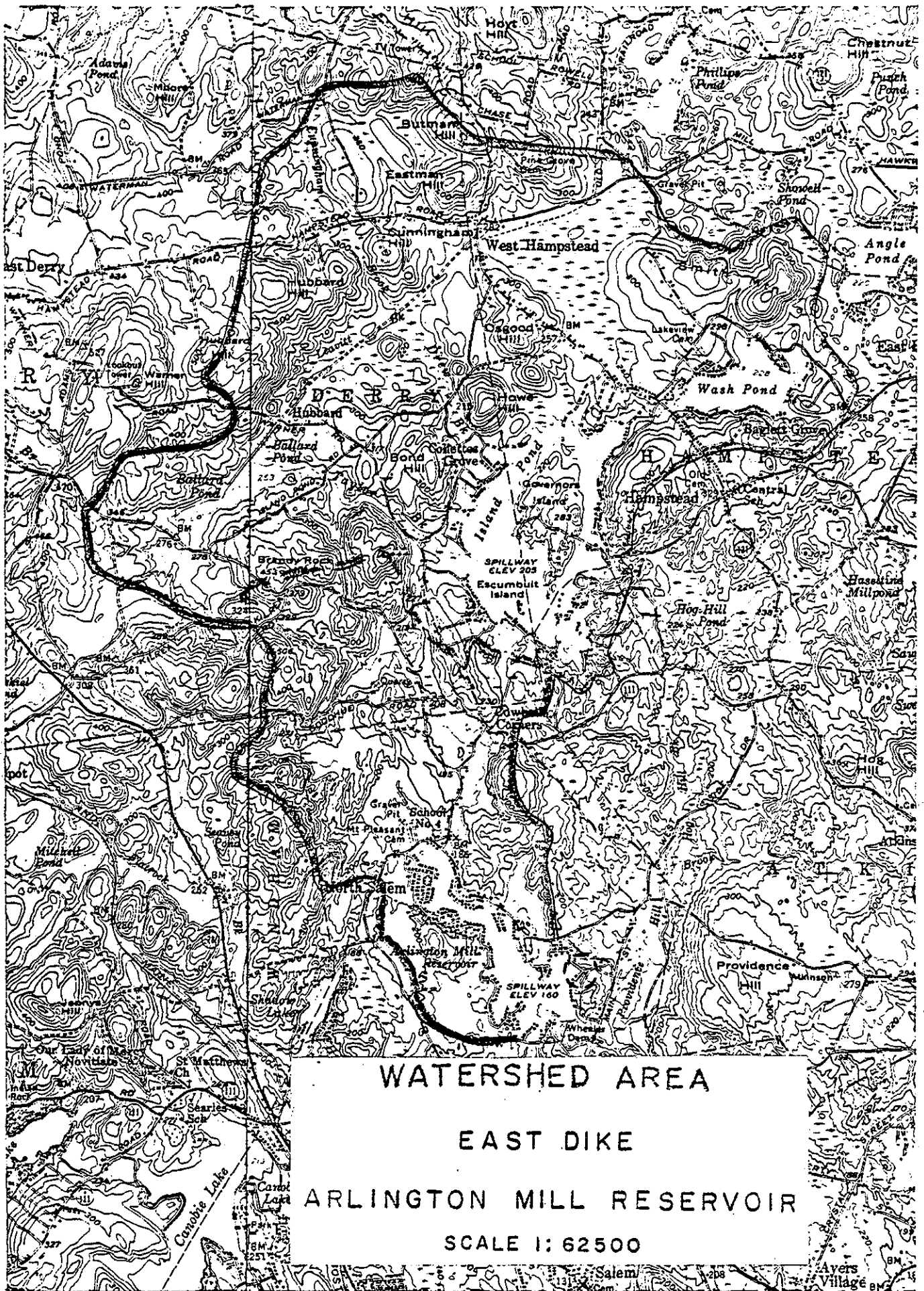
with surcharge effect, this additional spillway should be adequate.

Alternative = Based on my experience, probably the other economical alternative is to convert West dike into an additional spillway, that is change the road into bridge with box culverts. Since the height of the west dike is only about 10 ft. it should be easier to convert it into a spillway than Wheeler Dam. Also, originally, the downstream side of the West Dike has a stream, so, the discharge channel still there. The Box Culvert should have a invert elev. 161.5 ft. MSL. so that the flushboards still can be used. The width of the Box Culvert should be determined by detailed flood routing, the height of the Box should be at least 3.5 ft.

II Visual Inspection and Conclusions:

- a) Arlington Mill Reservoir spillway's left retaining wall (wing wall) is not high enough, flood flow may over spill from top of the retaining wall and wash out some of the soil near the toe of the dam. Although, the effect on the safety of the dam may not be serious, it is suggested that some riprap should be placed to protect the earth surface.
- b) Arlington Mill Reservoir does not have enough spillway capacity to pass the peak inflow of PMF, even by neglecting wave effect and considering surcharge effect. Its normal capacity (with wave effect) only amounts to 6300 cfs and its maximum capacity (neglecting wave effect) amounts to 8600 cfs. Outlet conduits could discharge 1450 cfs. So, the max. total spillway capacity (includes outlet discharge) is about 10,050 cfs. By including one-foot surcharge, to use the concrete gravity section of the dam as additional spillway, it has combined maximum capacity of about 12,600 cfs. The peak inflow of PMF is about 22,330 cfs.

- c) Of the three 4-ft diameter outlet conduits only one is operatable at present, the other two have not been used for a long time. If all three can be used as emergency spillway, it would have a capacity of 1400 - 1500 cfs.
- d) By assuming that the Big Island Pond Dam would stand overtopping and not fail, its surcharge effect would reduce the peak inflow of PMF to Arlington Mill Reservoir from 22,330 cfs to 17,000 cfs, with the outlet conduits, and the reservoir surcharge, an additional spillway is still needed to prevent overtopping its earth embankment.
- e) To provide adequate spillway capacity, an additional Ogee spillway with crest elevation at 161.5 M.S.L. with a length of 50 ft is needed.
- f) It seems more economical to convert the West Dike into a box culvert bridge type road to provide additional required spillway capacity. As to the height, the width, the invert elevation of the box culvert, all should be determined by detail flood routing.



APPENDIX E
INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS



INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR. DIST.	STATE	COUNTY	CONGR. DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE
NH	27	NED	NH	015	02				EAST DIKE ARLINGTON MILL RESERVOIR	4248.8	7112.5	15AUG78

POPULAR NAME	NAME OF IMPOUNDMENT
	ARLINGTON MILL RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	04	SPICKET RIVER OFFSTREAM	SALEM	2	20100

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCT. HEIGHT (FT.)	HYDRAU. HEIGHT (FT.)	IMPOUNDING CAPACITIES	DIST	OWN	FED	R	PRV/FED	SCS	A	YER/DATE
RECTPG	1922	S	40	32	MAXIMUM (ACRE-FT.) 3110		NED	N	N	N	N	N	04AUG78

REMARKS

D/S HAS	SPILLWAY	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY	NAVIGATION LOCKS
1	520 N		22750		

OWNER	ENGINEERING BY	CONSTRUCTION BY
SPICKET RIVER CORP	HK BARROWS -CONSULT ENGR	MP CUNNINGS CONST CO

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NH WATER RES BD	NH WATER RES BD	NH WATER RES BD	NH WATER RES BD

INSPECTION BY	INSPECTION DATE	AUTHORITY FOR INSPECTION
WHITMAN + HOWARD, INC	07JUN78	PL 92-367

REMARKS